Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead

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B.2.8 SOUTH-CENTRAL CALIFORNIA STEELHEAD

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B.2.8.1 Summary of Previous BRT Conclusions

The geographic range of the ESU was determined to extend from the Pajaro River basin in Monterey Bay south to, but not including, the Santa Maria River Basin near the town of Santa Maria. The ESU was separated from steelhead populations to the north on the basis of genetic data (mitochondrial DNA and allozymes), and from steelhead populations to the south on the basis of a general faunal transition in the vicinity of Point Conception. The genetic differentiation of steelhead populations within the same ESU, and the genetic differentiation between ESUs, appears to be greater in the south than in Northern California or the Pacific Northwest; however the conclusion is based on genetic data from a small number of populations.

Summary of major risks and status indicators

Risks and limiting factors—Numerous minor habitat blockages were considered likely throughout the region; other typical problems were thought to be dewatering from irrigation and urban water diversions, and habitat degradation in the form of logging on steep erosive slopes, agricultural and urban development on floodplains and riparian areas, and artificial breaching of estuaries during periods when they are normally closed off from the ocean by a sandbar.

Status indicators—Historical data on this ESU are sparse. In the mid 1960s, the CDFG (1965) estimated that the ESU-wide run size was about 17,750 adults. No comparable recent estimate exists; however, recent estimates exist for five river systems (Pajaro, Salinas, Carmel, Little Sur, and Big Sur), indicating runs of fewer than 500 adults where previously runs had been on the order of 4,750 adults (CDFG 1965). Time-series data only existed for one basin (the Carmel River), and indicated a decline of 22% per year over the interval 1963 to 1993 (see below for a review of this conclusion).

Many of the streams were thought to have somewhat to highly impassable barriers, both natural and anthropogenic, and in their upper reaches to harbor populations of resident trout. The relationship between anadromous and resident *O. mykiss* is poorly understood in this ESU, but was thought to play an important role in its population dynamics and evolutionary potential. A status review update conducted in 1997 (NMFS 1997) listed numerous reports of juvenile *O. mykiss* in many coastal basins; but noted that the implications for adult numbers were unclear. They also discussed the fact that certain inland basins (the Salinas and Pajaro systems) are rather different ecologically from coastal basins.

Previous BRT Conclusions

The original BRT (Busby et al. 1996) concluded that the ESU was in danger of extinction, due to 1) low total abundance; and 2) downward trends in abundance in those stocks for which data existed. The negative effects of poor land-use practices and trout stocking were also noted. The major area of uncertainty was the lack of data on steelhead run sizes, past and present. The status review update (NMFS 1997) concluded that abundance had slightly increased in the years immediately preceding, but that overall abundance was still low relative to historical numbers. They also expressed a concern that high juvenile abundance and low adult abundance observed in some datasets suggested that many or most juveniles were potentially resident fish (i.e. rainbow trout). The BRT convened for the update was nearly split on whether the fish were in danger of extinction, or currently not endangered but likely to become so in the foreseeable future, with the latter view holding a slight majority.

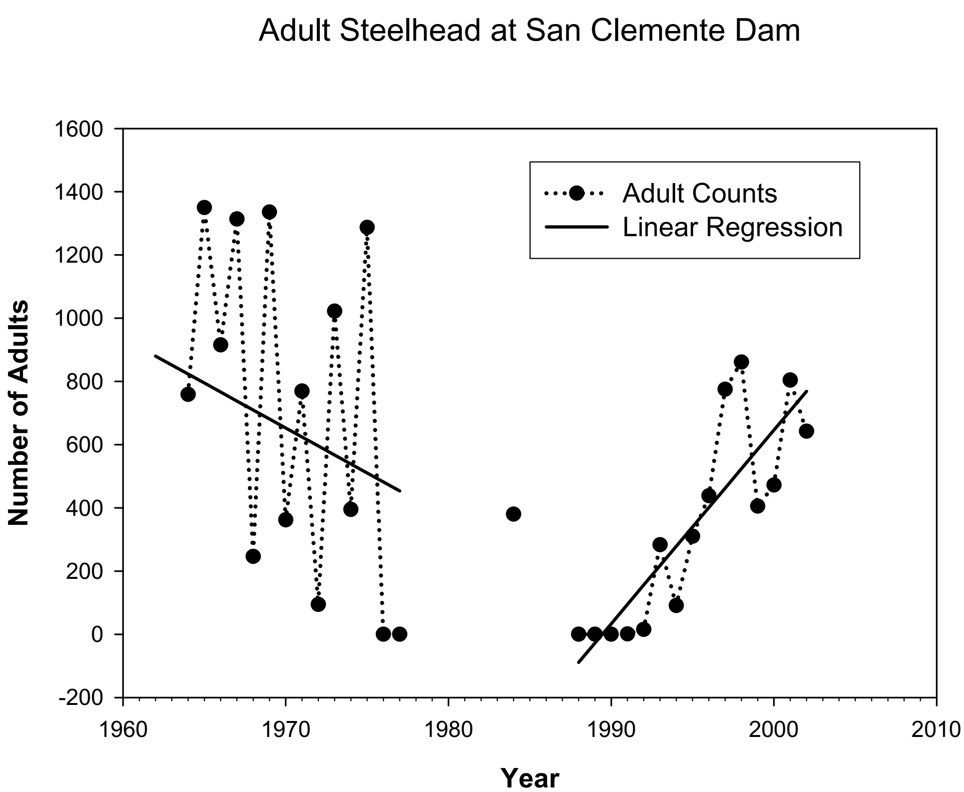

Figure B.2.8.1. Adult counts at San Clemente Dam, Carmel River. Data from the Monterey Peninsula Water Management District. See Snider (1983) for methods of counting fish before 1980; these early data are subject to substantial observation error (*N.B.* the regression line is not significantly different from flat). The increase during the 1990s followed a severe drought (and concurrent dewatering of the mainstem by a water district) in the late 1980s and early ‘90s.

Listing Status

The ESU was listed as threatened in 1997.

B.2.8.2 New Data and Updated Analyses

There are three new significant pieces of information: 1) updated time-series data concerning dam counts made on the Carmel River (MPWMD 2002) (See analyses section below for further discussion); 2) a comprehensive assessment of the current geographic distribution of *O. mykiss* within the ESU's historical range (Boughton & Fish MS; see next paragraph); and (3) changes in harvest regulations since the last status review (see next section).

Table B.2.8.1. Estimates of historical run sizes from the previous status review (Busby 1996).

River Basin	Run size estimate	Year	Reference
Pajaro R.	1,500	1964	McEwan and Jackson 1996
	1,000	1965	McEwan and Jackson 1996
	2,000	1966	McEwan and Jackson 1996
Carmel R.	20,000	1928	CACSS (1988)
	3,177	1964 – 1975	Snider (1983)
	2,000	1988	CACSS (1988)
	<4,000	1988	Meyer Resources (1988)

Current distribution vs. historical distribution—In 2002, an extensive study was made of steelhead occurrence in most of the coastal drainages between the northern and southern geographic boundaries of the ESU (Boughton and Fish MS). Steelhead were considered to be present in a basin if adult or juvenile *O. mykiss* were observed in any stream reach that had access to the ocean (i.e. no impassable barriers between the ocean and the survey site), in any of the years 2000-2002 (i.e. within one steelhead generation). Of 36 drainages in which steelhead were known to have occurred historically, between 86% and 94% were currently occupied by *O. mykiss*. The range in the estimate of occupancy occurs because three basins could not be assessed due to restricted access. Of the vacant basins, two were considered to be vacant because they were dry in 2002, and one was found to be watered but a snorkel survey revealed no *O. mykiss*. One of the "dry" basins—Old Creek—is dry because no releases were made from Whale Rock Reservoir; however, a land-locked population of steelhead is known to occur in the reservoir above the dam.

Occupancy was also determined for 18 basins with no historical record of steelhead occurrence. Three of these basins—Los Osos, Vicente, and Villa Creeks—were found to be occupied by *O. mykiss*. It is somewhat surprising that no previous record of steelhead seems to exist for Los Osos Creek, near Morro Bay and San Luis Obispo.

The distribution of steelhead among the basins of the region is not much less than what occurred historically, so despite the widespread declines in habitat quality and population sizes, regional extirpations have not yet occurred. This conclusion rests on the assumption that juveniles inhabiting stream reaches with access to the ocean will undergo smoltification and thus are truly steelhead.

Three analyses are made below: 1) A critical review of the historical run sizes cited in the previous status review, 2) an assessment of recent trends observed in the adult counts being made on the Carmel River; and 3) a summary of new sport-fishing regulations in the region.

Review of historical run sizes—Estimates of historical sizes for a few runs were described in the previous status review (Busby et al. 1996), and are here reproduced in Table B.2.8.1.

The recent estimates for the Pajaro River (1,500, 1,000, 2,000) were reported in McEwan and Jackson (1996), but the methodology and dataset used to produce the estimates were not described. CACCS (1988) suggested an annual run size of 20,000 adults in the Carmel River of the 1920s, but gave no supporting evidence for the estimate. Their 1988 estimate of 2,000 adults also lacked supporting evidence. Meyer Resources (1988) provides an estimate of run size, but was not available for review at the time of this writing.

Snider (1983) examined the Carmel River and produced many useful data. In the abstract of his report he gave an estimate of 3,177 fish as the mean annual smolt production for 1964 through 1975; Busby et al. (1996) mistakenly cited this estimate as an estimate of run size. Snider's "3,177" figure may itself be a mistake, as it disagrees with the information in the body of the report, which estimates annual smolt production in the year 1973 as 2,708 smolts, and in the year 1974 as 2,043 smolts. Snider (1983) also gives adult counts for fish migrating upstream through the fish ladder at San Clemente Dam, for the years 1964 through 1975 (data were not reported in Busby et al. 1996; but were apparently the basis for the 22% decline reported by them. See Figure B.2.8.1 for the actual counts.). The mean run size from these data is 821 adults. To make these estimates, visual counts were made twice a day by reducing the flow through the ladder and counting the fish in each step; thus they may underestimate the run size by some unknown amount if fish moved completely through the ladder between counts (an electronic counter was used in 1974 and 1975 and presumably is more accurate). In addition, San Clemente Dam occurs 19.2 miles from the mouth of the river and a fraction of the run spawns below the dam (CDFG biologists estimate the fraction to be one third of the run, based on redd surveys).

Thus, much of the historical data used in the previous status review are highly uncertain. The most reliable data are the Carmel River dam counts, which were not reported in the previous status review. Further analysis of these data are described below.

Abundance in the Carmel River—The Carmel River data are the only time-series for the ESU. The data suggest that the abundance of adult spawners in the Carmel River has increased since the last status review (Figure B.2.8.1.). A continuous series of data exists for 1964 through 1977, although the data are probably incomplete to various degrees for each year (i.e. the counts are probably incomplete, and the year-to-year fluctuations may be mostly due to observation error rather than population variability). A regression line drawn through the data indicates a downward trend, but the trend is not statistically significant (slope = -28.45; R^2 = 0.075; F = 1.137; p = 0.304;). The 22% decline reported by Busby et al. (1996) is apparently based on these data in comparison with the low numbers of the early 1990s.

Continuous data have also been collected for the period 1988 through 2002. The beginning of this time series has counts of zero adults for three consecutive years, then shows a rapid increase in abundance. The trend is strongly upward (see Table B.2.6.3). The time series is too short to make a reliable estimate of mean lambda. The observed positive trend could conceivably be due either to improved conditions (i.e. mean lambda greater than one), substantial immigration or transplantation, or the transient effects of age structure. Improved conditions seem by far the most likely explanation, as the basin has been the subject of intensive fisheries management since the early 1990s. According to the Monterey Peninsula Water Management

District, the entity conducting much of the restoration of the basin's steelhead fishery, the likely reasons for the positive trend are due to improved conditions, namely

> "Improvements in streamflow patterns, due to favorable natural fluctuations…since 1995; …actively manag[ing] the rate and distribution of groundwater extractions and direct surface diversions within the basin; changes to Cal-Am's [dam] operations … providing increased streamflow below San Clemente Dam; improved conditions for fish passage at Los Padres and San Clemente Dams …; recovery of riparian habitats, tree cover along the stream, and increases in woody debris…; extensive rescues … of juvenile steelhead over the last ten years … ; transplantation of the younger juveniles to viable habitat upstream and of older smolts to the lagoon or ocean; and implementation of a captive broodstock program by Carmel River Steelhead Association and California Department of Fish & Game (CDFG), [including] planting … from 1991 to1994." (MPWMD 2001).

Even so, the rapid increase in adult abundance from 1991 (one adult) to 1997 (775 adults) seems too great to attribute simply to improved reproduction and survival of the local steelhead. There are a number of possibilities: substantial immigration or transplantation may have boosted abundance, or perhaps there was a large population of resident trout that has begun producing smolts at a higher rate under improved freshwater conditions. The transplantation hypothesis is thought unlikely: although transplantation of juveniles occurred (in the form of rescues from the lower mainstem during periods in which it was dewatered), CDFG biologists consider the scale of these efforts to be too small to effect the large increase in run size that has been observed. The scale of immigration (i.e. straying) is not known but may be a significant factor. As for the role of resident trout in producing smolts, the phenomenon is known to occur but the environmental triggers have not yet been worked out. One hypothesis, congruent with the Carmel River situation, is that environmental conditions affect growth rate of juveniles, which affects propensity to smolt into the anadromous form.

The rapid increase in adult abundance in the Carmel River system is thus very interesting. At this point two conclusions seem warranted: 1) Upon improvement of freshwater conditions such as those described above, the adult runs are capable of rapid increase in this ESU, due either to resilience of steelhead populations, high stray rates, or ability of resident trout to produce smolts. Either mechanism might allow the fish to rapidly take advantage of improved conditions, suggesting a high potential for rapid recovery in this ESU if the proper actions were taken. 2) Although some component of the increase is probably due to improved ocean conditions, it would be a mistake to assume comparable increases have occurred in other basins of the ESU, as they have not been the focus of such intensive management efforts.

Possible changes in harvest impacts

Since the original status review of Busby et al. (1996), regulations concerning sport fishing have been changed in a way that probably reduces extinction risk for the ESU.

Sport harvest of steelhead in the ocean is prohibited by the California Department of Fish and Game (CDFG 2002a), and ocean harvest is a rare event (M. Mohr, NMFS, pers. comm.), so effects on extinction risk are probably negligible. For freshwaters, CDFG (2002) describes the current regulations. Summer trout fishing is allowed in some systems, often with a two- or five-bag limit. These include significant parts of the Salinas system (upper Arroyo Seco and Nacimiento above barriers; the upper Salinas; Salmon Creek; and the San Benito River in the Pajaro system (All: bag limit five trout). Also included in the summer fisheries is the Carmel River above Los Padres Dam (bag limit two trout, between 10" and 16"). A few other creeks have summer catch-and-release regulations. The original draft of the Fishery Management and Evaluation Plan (CDFG 2000) recommended complete closure of the Salinas system to protect the steelhead there, but the final regulations did not implement this recommendation, allowing both summer trout angling and winter-run catch-and-release steelhead angling in selected parts of the system (CDFG 2002).

The regulations allow catch-and-release winter-run steelhead angling in many of the river basins occupied by the ESU, specifying that all wild steelhead must be released unharmed. There are significant restrictions on timing, location, and gear used for angling. A recent draft Fisheries Evaluation and Management Plan (CDFG 2001b) has been prepared, and argues that the only mortality expected from a no-harvest fishery is from hooking and handling injury or stress. They estimate this mortality rate to be about 0.25% - 1.4%. This estimate is based on angler capture rates measured in other river systems throughout California (range: 5% - 28%), multiplied by an estimated mortality rate of 5% once a fish is hooked. The latter mortality estimate is consistent with a published meta-analysis of hooking mortality (Schill and Scarpella 1997), but experimental studies on the subject—from which the estimates are made—tend to measure mortality only for a period of a few days or a week after capture (e.g. Titus and Vanicek 1988).

The Fishery Management and Evaluation Plan contains no extensive plans for monitoring fish abundance. Although the closure of many areas, and institution of catch-and-release elsewhere, is expected to reduce extinction risk for the ESU, this risk reduction cannot be estimated quantitatively from the existing data, due to the fact that natural abundance is not being measured.

Resident *O. mykiss* considerations

Resident (non-anadromous) populations of *O. mykiss* were assigned to one of three categories for the purpose of provisionally determining ESU membership (See "Resident Fish" in the introduction for a description of the three categories and default assumptions about ESU membership). The third category consists of resident populations that are separated from anadromous conspecifics by recent human-made barriers such as dams without fish ladders. No default assumption about ESU membership was possible for Category 3 populations, so they are here considered case-by-case according to available information.

As of this writing there are few data on occurrence of resident populations and even fewer on genetic relationships. A provisional survey of the occurrence of Category 3 populations in the ESU (see Appendix B.5.2) revealed the following: There are four significant Category 3 populations within the original geographic range of the ESU (Appendix B.5.2)—two in the Salinas system, one behind Whale Rock Dam near Cayucos, and one behind the Lopez reservoir on Arroyo Grande Creek. The two in the Salinas system occur behind the dams on the Nacimiento and San Antonio Rivers, which currently block what were reported to be two of the three principal steelhead spawning areas in the basin (the other being in Arroyo Seco; Titus et al.

2003). Resident populations occur above these dams and stocking is ongoing (Appendix B.5.2). A third major barrier occurs in the headwaters of the Salinas itself; stocking currently occurs above this dam. Steelhead reportedly spawned in these streams before the dam was built, but the runs were probably relatively small and sporadic.

The Whale Rock Reservoir has a resident population that is reported to make steelhead-like runs up several tributaries for spawning. The reservoir has an associated hatchery program; see the previous section above for details on genetic studies, stocking records, *etc*.

According to David Starr Jordan, the area now blocked by the Lopez dam on Arroyo Grande Creek was originally well known as a significant steelhead area (cited in Titus et al. 2003). A resident population currently exists above this dam, and stocking is ongoing (Table B.5.1.1). We are not aware of any studies of the population's genetic affinities.

Minor barriers—defined here as blocking less than 100 sq. mi. of watershed—are numerous within the geographic range of the ESU. A nonzero number of Category 3 populations undoubtedly exist above these barriers but there are insufficient data at the present time to make a comprehensive assessment.

B.2.8.3. New Hatchery Information

The only hatchery stock being considered in this ESU is the one at Whale Rock Hatchery. This stock was assigned to one of three categories for the purpose of determining ESU membership at some future date (See "Artificial Propagation" in the introduction for a description of the three categories and related issues regarding ESU membership). To make the assignment, data about broodstock origin, size, management and genetics were gathered from fisheries biologists and are summarized below.

Whale Rock Hatchery (Whale Rock Steelhead [CDFG])

Whale Rock Reservoir was created in 1961 by placing a dam on Old Creek, 2 km upstream from the coast. Old Creek had supported a large steelhead run previous to construction of the dam and these fish were presumably trapped behind the dam (the creek is usually dewatered below the dam so no population occurs there at all). Whale Rock Hatchery was established in 1992 as an effort to improve the sport fishery in the reservoir after anglers reported a decline in fishing success. The original Whale Rock broodstock (40 fish) were collected at a temporary weir placed in the reservoir at the mouth of Old Creek Cove (Nielsen et al. 1997). Adult fish were trapped in the shallows of the reservoir using nets that are set during late winter and spring as the fish begin their migration upstream from the reservoir into Old Creek. The fish are held in an enclosure while they are monitored for ripeness. Eggs and sperm are collected from fish using non-lethal techniques, and then the adult fish are returned to the reservoir. Fish were originally hatched and raised at the Whale Rock Hatchery located below the dam at the maintenance facility, but are now raised at the Fillmore Hatchery in Ventura County. The fry are cared for until September or November at which time they are released back into the reservoir as 3-5" fingerling trout.

Broodstock origin and history—Hatchery operations began in 1992 and have been sporadic since. The project is a cooperative venture between CDFG and private parties. Fish were raised in 1992, 1994, 2000, and 2002 (John Bell, personal communication). All broodstock are taken from the reservoir.

Broodstock size/natural population size—An average of 121 fish were spawned. Spawning success has been poor. There are no population estimates for the reservoir and the hatchery fish are not marked.

Management—The current program goal is to increase angling success in Whale Rock Reservoir.

Population genetics—Neilsen et al. (1997) found that significant genetic relatedness occurs between the Whale Rock Hatchery stock and wild steelhead in the Santa Ynez River and Malibu creeks, two basins to the south. She reported a loss of genetic diversity within the hatchery stock.

Category—The hatchery was determined to belong to Category 2 (SSHAG 2003; Appendix B.5.3). Broodstock are taken from the source population, but the small population could easily lead to significant genetic bottlenecks.

B.3 STEELHEAD BRT CONCLUSIONS

The ESA (Sec. 3) allows listing of "species, subspecies, and distinct population segments." The option to list subspecies is not available for Pacific salmon, since no formally recognized subspecies exist. However, a number of subspecies have been identified for *O. mykiss*, including two that occur in North America and have anadromous populations. According to Behnke (1992), *O. mykiss irideus* (the "coastal" subspecies) includes coastal populations from Alaska to California (including the Sacramento River), while *O. mykiss gairdneri* (the "inland" subspecies) includes populations from the interior Columbia, Snake and Fraser Rivers. Both subspecies thus include populations within the geographic range of this updated status review, but both also include northern populations outside the geographic range considered here. The BRT did not attempt to evaluate extinction risk to *O. mykiss* at the species or subspecies level; instead, we evaluated risk at the distinct population segment (ESU) level, as for the other species considered in this report.

Snake River steelhead ESU

A majority (over 70%) of the BRT votes for this ESU fell in the "likely to become endangered" category, with small minorities falling in the "danger of extinction" and "not likely to become endangered" categories (Table B.3.1). The BRT did not identify any extreme risks for this ESU but found moderate risks in all the VSP categories (mean risk matrix scores ranged from 2.5 for spatial structure to 3.2 for growth rate/productivity) (Table B.3.2). The continuing depressed status of B-run populations was a particular concern. Paucity of information on adult spawning escapements to specific tributary production areas makes a quantitative assessment of viability for this ESU difficult. As indicated in previous status reviews, the BRT remained concerned about the replacement of naturally produced fish by hatchery fish in this ESU; naturally produced fish now make up only a small fraction of the total adult run. Again, lack of key information considerably complicates the risk analysis. Although several large production hatcheries for steelhead occur throughout this ESU, relatively few data exist regarding the numbers and relative distribution of hatchery fish that spawn naturally, or the consequences of such spawnings when they do occur.

On a more positive note, sharp upturns in 2000 and 2001 in adult returns in some populations and evidence for high smolt-adult survival indicate that populations in this ESU are still capable of responding to favorable environmental conditions. In spite of the recent increases, however, abundance in most populations for which there are adequate data are well below interim recovery targets (NMFS 2002).

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (e.g., in the Palouse and Malad Rivers) are not. Recent genetic data suggest that native resident *O. mykiss* above Dworshak Dam on the North Fork Clearwater River should be considered part of this ESU, but hatchery rainbow trout that have been introduced to that and other areas would not. The BRT did not attempt to resolve the ESU status of resident fish residing above the Hell's Canyon Dam complex, as little new information is available relevant to this issue. However, Kostow (2003) suggested that, based on substantial ecological differences in habitat, the anadromous *O. mykiss* that historically occupied basins upstream of Hells Canyon (e.g., Powder, Burnt, Malheur, Owhyee rivers) may have been in a separate ESU. For many BRT members, the presence of relatively numerous resident fish mitigated the assessment of extinction risk for the ESU as a whole.

Upper Columbia River steelhead ESU

A slight majority (54%) of the BRT votes for this ESU fell in the "danger of extinction" category, with most of the rest falling in the "likely to become endangered" category (Table B.3.1). The most serious risk identified for this ESU was growth rate/productivity (mean score 4.3); scores for the other VSP factors were also relatively high, ranging from 3.1 (spatial structure) to 3.6 (diversity) (Table B.3.2). The last 2-3 years have seen an encouraging increase in the number of naturally produced fish in this ESU. However, the recent mean abundance in the major basins is still only a fraction of interim recovery targets (NMFS 2002). Furthermore, overall adult returns are still dominated by hatchery fish, and detailed information is lacking regarding productivity of natural populations. The ratio of naturally produced adults to the number of parental spawners (including hatchery fish) remains low for upper Columbia steelhead. The BRT did not find data to suggest that the extremely low replacement rate of naturally spawning fish (estimated adult: adult ratio was only 0.25-0.3 at the time of the last status review update) has improved substantially.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (e.g., in the Entiat, Methow, and perhaps Okanogan basins) are not. Resident fish potentially occur in all areas in the ESU used by steelhead. Case 3 resident fish above Conconully Dam are of uncertain ESU affinity. The BRT did not attempt to resolve the ESU status of resident fish residing above Grand Coulee Dam, as little new information is available relevant to this issue. Possible ESU scenarios for these fish include 1) they were historically part of the ESU and many of the remnant resident populations still are part of this ESU; 2) they were historically part of the ESU but no longer are, due to either introductions of hatchery rainbow trout or rapid evolution in a novel environment; or 3) they were historically part of a separate ESU. For many BRT members, the presence of relatively numerous resident fish mitigated the assessment of extinction risk for the ESU as a whole.

Middle Columbia River steelhead ESU

A slight majority (51%) of the BRT votes for this ESU fell in the "likely to become endangered" category, with a substantial minority (49%) falling in the "not likely to become endangered" category (Table B.3.1). The BRT did not identify any extreme risks for this ESU but found moderate risks in all the VSP categories (mean risk matrix scores ranged from 2.5 for diversity to 2.7 for abundance) (Table B.3.2).

This ESU proved difficult to evaluate for two reasons. First, the status of different populations within the ESU varies greatly. On the one hand the abundance in two major basins, the Deschutes and John Day, is relatively high and over the last five years is close to or slightly over the interim recovery targets (NMFS 2002). On the other hand, steelhead in the Yakima basin, once a large producer of steelhead, remain severely depressed (10% of the interim recovery target), in spite of increases in the last 2 years. Furthermore, in recent years escapement to spawning grounds in the Deschutes River has been dominated by stray, out-of-basin (and largely out-of-ESU) fish—which raises substantial questions about genetic integrity and productivity of the Deschutes population. The John Day is the only basin of substantial size in which production is clearly driven by natural spawners. For the other major basin in the ESU (the Klickitat), no quantitative abundance information is available. The other difficult issue centered on how to evaluate contribution of resident fish, which according to Kostow (2003) and other sources are very common in this ESU and may greatly outnumber anadromous fish. The BRT concluded that the relatively abundant and widely distributed resident fish mitigated extinction risk in this ESU somewhat. However, due to significant threats to the anadromous component the majority of BRT members concluded the ESU was likely to become endangered.

Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (e.g., in Deschutes and John Day basins) are not. Case 3 resident fish above Condit Dam in the Little White Salmon; above Pelton and Round Butte Dams (but below natural barriers) in the Deschutes; and above irrigation dams in the Umatilla Rivers are of uncertain ESU status.

Lower Columbia River steelhead ESU

A large majority (over 79%) of the BRT votes for this ESU fell in the "likely to become endangered" category, with small minorities falling in the "danger of extinction" and "not likely to become endangered" categories (Table B.3.1). The BRT found moderate risks in all the VSP categories, with mean risk matrix scores ranging from 2.7 for spatial structure to 3.3 for both abundance and growth rate/productivity) (Table B.3.2). All of the major risk factors identified by previous BRTs still remain. Most populations are at relatively low abundance, and those with adequate data for modeling are estimated to have a relatively high extinction probability. Some populations, particularly summer run, have shown higher returns in the last 2-3 years. The Willamette Lower Columbia River TRT (Myers et al. 2002) has estimated that at least four historical populations are now extinct. The hatchery contribution to natural spawning remains high in many populations.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (e.g., in upper Clackamas, Sandy, and some of the small tributaries of the Columbia River Gorge) are not. Case 3 resident fish above dams on the Cowlitz, Lewis, and Sandy Rivers are of uncertain ESU status.

Upper Willamette River steelhead ESU

The majority (over 76%) of the BRT votes for this ESU fell in the "likely to become endangered" category, with small minorities falling in the "danger of extinction" and "not likely to become endangered" categories (Table B.3.1). The BRT did not identify any extreme risks for this ESU but found moderate risks in all the VSP categories (mean risk matrix scores ranged from 2.6 for diversity to 2.9 for both spatial structure and growth rate/productivity) (Table B.3.2). On a positive note, after a decade in which overall abundance (Willamette Falls count) hovered around the lowest levels on record, adult returns for 2001 and 2002 were up significantly, on par with levels seen in the 1980s. Still, the total abundance is small for an entire ESU, resulting in a number of populations that are each at relatively low abundance. The recent increases are encouraging but it is uncertain whether they can be sustained. The BRT considered it a positive sign that releases of the "early" winter-run hatchery population have been discontinued, but remained concerned that releases of non-native summer-run steelhead continue.

Because coastal cutthroat trout is a dominant species in the basin, resident *O. mykiss* are not as widespread here as in areas east of the Cascades. Resident fish below barriers are found in the Pudding/Molalla, Lower Santiam, Calapooia, and Tualatin drainages, and these would be considered part of the steelhead ESU based on the provisional framework discussed in the general Introduction. Resident fish above Big Cliff and Detroit Dams on the North Fork Santiam and above Green Peter Dam on the South Fork Santiam are of uncertain ESU affinity. Although no obvious physical barrier separates populations upstream of the Calapooia from those lower in the basin, resident *O. mykiss* in these upper reaches of the Willamette basin are quite distinctive both phenotypically and genetically and are not considered part of the steelhead ESU.

Northern California steelhead ESU

The majority (74%) of BRT votes were for "likely to become endangered," with the remaining votes split about equally between "in danger of extinction" and "not warranted" (Table B.3.1). Abundance and productivity were of some concern (scores of 3.7; 3.3 in the risk matrix); spatial structure and diversity were of lower concern (scores of 2.2; 2.5); although at least one BRT member gave scores as high as 4 for each of these risk metrics (Table B.3.2).

The BRT considered the lack of data for this ESU to be a source of risk due to uncertainty. The lack of recent data is particularly acute for winter runs. While there are older data for several of the larger river systems that imply run sizes became much reduced since the early twentieth century, there are no recent data suggesting much of an improvement.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of the Northern California Coast Steelhead ESU, while those above long-standing natural barriers are not. Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Resident fish above recent (usually man-made) barriers--including Robert W. Matthews Dam on the Mad River and Scott Dam on the Eel River--but below natural barriers are of uncertain ESU affinity. In this ESU, the inclusion of resident fish would not greatly increase the total numbers of fish, and the resident fish have not been exposed to large amounts of hatchery stocking.

Central California Coast steelhead ESU

The majority (69%) of BRT votes were for "likely to become endangered," and another 25% were for "in danger of extinction" (Table B.3.1). Abundance and productivity were of relatively high concern (mean score of 3.9 for each, with a range of 3 to 5 for each), and spatial structure was also of concern (score 3.6) (Table B.3.2). Predation by pinnipeds at river mouths and during the ocean phase was noted as a recent development posing significant risk.

There were no time-series data for this ESU. A variety of evidence suggested the largest run in the ESU (the Russian River winter steelhead run) has been reduced in size and continues to be reduced in size. Concern was also expressed about the populations in the southern part of the range of the ESU--notably populations in Santa Cruz County and the South Bay area.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of the Central California Coast Steelhead ESU, while those above long-standing natural barriers are not. Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Resident fish above recent (usually man-made) barriers--including Warm Springs Dam on Dry Creek, Russian River; Coyote Dam on the East Fork Russian River; Seeger Dam on Lagunitas Creek; Peters Dam on Nicasio Creek, Lagunitas Creek; and Standish Dam on Coyote Creek--but below natural barriers are of uncertain ESU affinity. In this ESU, an estimated 22% of historical habitat is behind recent barriers. The only relevant biological information about the populations above these barriers pertains to Alameda Creek, and suggests that some but not all populations above Dam 1 are genetically similar to populations within the ESU. For some BRT members, the presence of resident fish mitigated the assessment of extinction risk for the ESU as a whole.

South-Central California Coast steelhead ESU

The majority (68%) of BRT votes were for "likely to become endangered," and another 25% were for "in danger of extinction" (Table B.3.1). The strongest concern was for spatial structure (score 3.9; range 3-5), but abundance and productivity were also a concern (Table B.3.2). The cessation of plants to the ESU from the Big Creek Hatchery (Central Coast ESU) was noted as a positive development, whereas continued predation from sport fishers was considered a negative development.

New data suggests that populations of steelhead exist in most of the streams within the geographic boundaries of the ESU; however, the BRT was concerned that the two largest river systems—the Pajaro and Salinas basins—are much degraded and have steelhead runs much reduced in size. Concern was also expressed about the fact that these two large systems are ecologically distinct from the populations in the Big Sur area and San Luis Obispo County, and thus their degradation affects spatial structure and diversity of the ESU. Much discussion centered on the dataset from the Carmel River, including the effects of the drought in the 1980s, the current dependence of the population on intensive management of the river system, and the vulnerability of the population to future droughts.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of the South-Central California Coast Steelhead ESU, while those above long-standing natural barriers are not. Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Resident fish above recent (usually man-made) barriers--including San Antonia, Nacimiento, and Salinas dams on the Salinas River; Los Padres Dam on the Carmel River; Whale Rock Dam on Old Creek; and Lopez Dam on Arroyo Grande Creek--but below natural barriers are of uncertain ESU affinity. In this ESU, little of the historical habitat is behind recent barriers and most of that on the Salinas River. For some BRT members, the presence of resident fish mitigated the assessment of extinction risk for the ESU as a whole.

Southern California steelhead ESU

The majority (81%) of BRT votes were for “in danger of extinction,” with the remaining 19% of votes being for “likely to become endangered” (Table B.3.1). Extremely strong concern was expressed for abundance, productivity, and spatial structure (mean scores of 4.8, 4.3, and 4.8, respectively, in the risk matrix), and diversity was also of concern (mean score of 3.6) (Table B.3.2).

The BRT expressed concern about the lack of data on this ESU, about uncertainty as to the metapopulation dynamics in the southern part of the range of the ESU, and about the fish’s nearly complete extirpation from the southern part of the range. Several members were concerned and uncertain about the relationship between the population in Sespe Canyon, which is supposedly a sizeable population, and the small run size passing through the Santa Clara River, which connects the Sespe to the ocean. There was some skepticism that flows in the Santa Maria River were sufficient to allow fish passage from the ocean to the Sisquoc River, another “stronghold” of *O. mykiss* in the ESU.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of the South California Steelhead ESU, while those above long-standing natural barriers are not. Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Resident fish above recent (usually man-made) barriers--including Twitchell Dam on the Cuyama River; Bradbury Dam on the Santa Ynez River; Casitas Dam on Coyote Creek, Ventura River; Matilija Dam on Matilija Creek, Ventura River; Santa Felicia Dam on Piru Creek, Santa Clara River; and Casitac Dam on Casitac Creek, Santa Clara River--but below natural barriers are of uncertain ESU affinity. In this ESU, a large portion of the original area is behind barriers, and the few density estimates that are available from this ESU indicate that the inclusion of area above recent barriers would substantially increase the number of fish in the ESU. Due to the extremely low numbers of anadromous fish in this ESU, it is possible that above-barrier populations contribute a significant number of fish to the below-barrier population by spill over. For some BRT members, the presence of resident fish mitigated the assessment of extinction risk for the ESU as a whole.

California Central Valley steelhead ESU

The majority (66%) of BRT votes were for “in danger of extinction”, and the remainder was for “likely to become endangered” (Table B.3.1). Abundance, productivity and spatial structure were of highest concern (4.2-4.4), although diversity considerations were of significant concern (3.6) (Table B.3.2). All categories received a 5 from at least one BRT member.

The BRT was highly concerned by the fact that what little new information was available indicated that the monotonic decline in total abundance and in the proportion of wild fish in the ESU was continuing. Other major concerns included the loss of the vast majority of historical spawning areas above impassable dams, the lack of any steelhead-specific status monitoring, and the significant production of out-of-ESU steelhead by the Nimbus and Mokelumne River fish hatcheries. The BRT viewed the anadromous life-history form as a critical component of diversity within the ESU and did not place much importance on sparse information suggesting widespread and abundant *O. mykiss* populations in areas above impassable dams. Dams both reduce the scope for expression of the anadromous life-history form, thereby greatly reducing the abundance of anadromous *O. mykiss*, and prevent exchange of migrants among resident populations, a process presumably mediated by anadromous fish.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of the California Central Valley Steelhead ESU, while those above long-standing natural barriers are not. Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Resident fish above recent (usually man-made) barriers--including Shasta Dam on the Upper Sacramento River; Whiskeytown Dam on Clear Creek; Black Butte Dam on Stony Creek; Oroville Dam on the Feather River; Englebright Dam on the Yuba River; Camp Far West Dam on the Bear River; Nimbus Dam on the American River; Commanche Dam on the Mokelumne River; New Hogan Dam on the Calaveras River; Goodwin Dam on the Stanislaus River; La Grange Dam on the Tuolumne River; and Crocker Diversion Dam on the Merced River--but below natural barriers are of uncertain ESU affinity. As noted above, collectively these dams have isolated a large fraction of historical steelhead habitat, and resident fish above the dams may outnumber ESU fish from below the dams.

Table B.3.1. Tally of FEMAT vote distribution regarding the status of 10 steelhead ESUs reviewed. Each of 16 BRT members allocated 10 points among the three status categories.

ESU	Danger of Extinction	Likely to Become Endangered	Not Likely to Become Endangered
Snake River[1]	14	103	23
Upper Columbia[1]	75	62	3
Middle Columbia[1]	1	71	68
Lower Columbia[2]	10	110	30
Upper Willamette[2]	7	106	37
Northern California	18	119	23
Central California Coast	40	111	9
South Central California	40	109	11
Southern California	129	31	0
Central Valley	106	54	0

[1] Votes tallied for 14 BRT members
[2] Votes tallied for 15 BRT members

Table B.3.2. Summary of risk scores (1 = low to 5 = high) for four VSP categories (see section "Factors Considered in Status Assessments" for a description of the risk categories) for the 10 steelhead ESUs reviewed. Data presented are means (range).

ESU	Abundance	Growth Rate/Productivity	Spatial Structure and Connectivity	Diversity
Snake River	3.1 (2-4)	3.2 (2-4)	2.5 (1-4)	3.1 (2-4)
Upper Columbia	3.5 (2-4)	4.3 (3-5)	3.1 (2-4)	3.6 (2-5)
Middle Columbia	2.7 (2-4)	2.6 (2-3)	2.6 (2-4)	2.5 (2-4)
Lower Columbia	3.3 (2-5)	3.3 (3-4)	2.7 (2-4)	3.0 (2-4)
Upper Willamette	2.8 (2-4)	2.9 (2-4)	2.9 (2-4)	2.6 (2-3)
Northern California	3.7 (3-5)	3.3 (2-4)	2.2 (1-4)	2.5 (1-4)
Central California Coast	3.9 (3-5)	3.9 (3-5)	3.6 (2-5)	2.8 (2-4)
South Central California	3.7 (2-5)	3.3 (2-4)	3.9 (3-5)	2.9 (2-4)
Southern California	4.8 (4-5)	4.3 (3-5)	4.8 (4-5)	3.6 (2-5)
Central Valley	4.4 (4-5)	4.3 (4-3)	4.2 (2-5)	3.6 (2-5)

B.4 REFERENCES

Adams, P. 2000. Memorandum to Rodney McInnis: Status review update for the steelhead northern California Evolutionarily Significant Unit. U.S. Dep. Commer., National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz/Tiburon Laboratory, Tiburon, California.

AFS (American Fisheries Society). 1991. Minutes of southern California steelhead meeting, US Fish and Wildlife Service Office, Ventura, California, January 22, 1991. Am. Fish. Soc., California-Nevada Chapter, Environmental Concerns Committee, 9 p. (Available from Trout Unlimited of California, 2530 San Pablo Ave., Suite D, Berkeley, CA 94702).

Alley, D. W., and Associates. 1994. Comparison of juvenile steelhead densities in 1981 and 1994 with estimates of total numbers of mainstem juveniles and expected numbers of adults returning to the San Lorenzo River, Soquel Creek and Corralitos Creek, Santa Cruz County, California. City of Santa Cruz Water Department, City of Watsonville Water Department Lompico County Water District San Lorenzo Valley Water District and Soquel Creek Water District. Project # 122-01, 123-01, 124-01, 125-01, Brookdale, California .

Alley, D. W., and Associates. 1995. Comparison of juvenile steelhead densities in 1981, 1994 and 1995 with an estimate of juvenile population size in the mainstem San Lorenzo River, with expected numbers of adults returning form juveniles reared in the mainstem river, Santa Cruz County, California. City of Santa Cruz Water Department, San Lorenzo Valley Water District and Lompico County Water District. Project # 135-01, 136-01. Brookdale, California.

Alley, D. W., and Associates. 1997. Comparison of juvenile steelhead densities in 1981 and 1994-96 in the San Lorenzo River and tributaries, with an estimate of juvenile population size in the mainstem river and expected adult returns from that production, Santa Cruz County, California. City of Santa Cruz Water Department and the San Lorenzo Valley Water District. Project # 143-01, 144-01. Brookdale, California.

Alley, D. W., and Associates. 1998. Comparison of juvenile steelhead densities in 1981 and 1994-97 in the San Lorenzo River and tributaries, Santa Cruz County, California; with an estimate of juvenile population size in the mainstem river and expected adult returns. City of Santa Cruz Water Department, and San Lorenzo Valley Water District. Project # 150-01. Brookdale, California .

Alley, D. W., and Associates. 1999. Comparisons of juvenile steelhead densities, population estimates and habitat conditions for the San Lorenzo River, Santa Cruz County, California, 1994-98; with predicted adult returns. City of Santa Cruz Water Department, Santa Cruz County Environmental Planning and the San Lorenzo Valley Water District. Project #150-02. Brookdale, California.

Alley, D. W., and Associates. 2000. Comparisons of juvenile steelhead densities, population estimates and habitat conditions for the San Lorenzo River, Santa Cruz County, California, 1995-99; with an index of adult returns. City of Santa Cruz Water Department, Santa Cruz County Environmental Planning and the San Lorenzo Valley Water District. Project #150-03. Brookdale, California.

Alley, D. W., and Associates. 2002. Comparison of juvenile steelhead densities in 1997 through 2001, in the San Lorenzo River and tributaries, Santa Cruz County, California; with an estimate of juvenile population size and an index of adult returns. City of Santa Cruz Water Department, San Lorenzo Valley Water District and NMFS. Project # 150-06. Brookdale, California .

Alley, D. W., and Associates. 2002. Comparison of juvenile steelhead densities in 1997 through 2001, in the San Lorenzo River and tributaries, Santa Cruz County, California; with an estimate of juvenile population size and an index of adult returns. City of Santa Cruz Water Department, San Lorenzo Valley Water District and NMFS. Draft report Project # 150-06. Brookdale, California .Anonymous. 1994. Oregon salmon and steelhead catch data, 1981-93. Unpublished.

Anonymous. 1995. 1995 Stock status review for winter steelhead, Mid-Willamette district, NW region.

Anonymous. 1997. ODFW Mid-Willamette Fish District unpublished files: winter steelhead Foster dam counts, Minto trap counts and run size estimates; Molalla R. spring chinook run size estimates through 1997.

Anonymous. 1998. Portland General Electric fish facility reports. Unpublished StreamNet Reference.

Anonymous. 1998. ODFW Columbia River Management unpublished files: Willamette Falls fish passage 1946-97.

Barnhart, R. A. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)--steelhead. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.60), 21 p.

Behnke, R. J. 1992. Native trout of western North America. Am. Fish. Soc. Monog. 6, 275 p. American Fisheries Society, Bethesda, MD.

Berg, L (ed.). 2001. Yakima Subbasin Summary (Draft). Northwest Power Planning Council, Portland, OR.

Berry, R. L. 1978. Salmon and steelhead sport catch statistics, 1978. Unpublished.

Bjornn, T. C. 1978. Survival, production, and yield of trout and chinook salmon in the Lemhi River, Idaho. Univ. Idaho, Coll. For., Wildl. Range Sci. Bull. 27, 57 p.

Boughton, D. A. and H. Fish. MS. The current regional distribution of steelhead (*Oncorhynchus mykiss*) in Southern California. Available from NOAA Fisheries, Southwest Science Center, 110 Shaffer Road, Santa Cruz, CA.

Brown, L. R. and P. B. Moyle. 1981. The impact of squawfish on salmonid populations: a review. N. Amer. J. Fish. Man. 1: 104 – 111.

Brown, L. R. and P. B. Moyle. 1997. Invading species in the Eel River, California: successes, failures, and relationships with resident species. Environmental Biology of Fishes 49: 271 – 291.

Bryson, D. 2001. Draft Imnaha Subbasin Summary. Prepared for the Northwest Power Planning Council. 241 p.

Burgner, R. L., J. T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 51, 92 p.

Busby, P. J., O. W. Johnson, T. C. Wainwright, F. W. Waknitz, and R. S. Waples. 1993. Status review for Oregon s Illinois River winter steelhead. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-10, 85 p.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-27, 261p.

CACSS (California Advisory Committee on Salmon and Steelhead). 1988. Restoring the balance. Calif. Dep. Fish Game, Sacramento, CA. 84 p.

Cardenas, M. 1996. Upper Sisquoc River survey. CDFG Report.

CDFG (California Department of Fish and Game). 1965. California fish and wildlife plan. Volume III supporting data: part B, inventory salmon-steelhead and marine resources. California Department of Fish and Game, Sacramento, California.679 p.

CDFG (California Department of Fish and Game). 1979. Nelson Creek wild trout management plan. California Department of Fish and Game, Sacramento, CA, 27 p.

CDFG (California Department of Fish and Game). 1982. 1982 status report of California wild and scenic rivers salmon and steelhead fisheries. Calif. Dept. Fish Game, Sacramento, CA, 159 p.

CDFG (California Department of Fish and Game). 1995. Letter to M. Schiewe for the ESA Administrative Record for west coast steelhead, dated 30 March 1995, 10 p. plus attachments. (Avail. from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

CDFG (California Department of Fish and Game). 2000. Fishery management and evaluation plan, south-central California coast evolutionarily significant unit, steelhead, draft document. CDFG, Fisheries Programs Branch, 1416 Ninth Street, Sacramento, CA.

CDFG (California Department of Fish and Game). 2000. Fishery management plan for the Upper Sacramento River (Box Canyon Dam to Lake Shasta) 2000 to 2005. California Department of Fish and Game, Sacramento, CA, 52 p.

CDFG (California Department of Fish and Game). 2001. Fishery management plan, Central Valley, California Evolutionary Significant Unit, Steelhead. California Department of Fish and Game, Sacramento, CA, 59 p.

CDFG (California Department of Fish and Game). 2001a. Fishery management and evaluation plan, Central California Coast Evolutionarily Significant Unit, draft.

CDFG (California Department of Fish and Game). 2001b. Fishery management and evaluation plan, South-Central California Coast Evolutionarily Significant Unit, draft.

CDFG (California Department of Fish and Game). 2002. 2002 Freshwater sportfishing regulations booklet. Available from CDFG, 1416 Ninth Street, Room 1320, Sacramento, CA 95814. 70 pp.

CDFG (California Department of Fish and Game). 2003. Letter from D. Marston (CDFG) to M. Martinez (NMFS), dated January 9, 2003.

Chilcote, M. W. 1998. Conservation Status of Steelhead in Oregon. Information Report 98-3. Oregon Department of Fish and Wildlife.

Chilcote, M. W. 2001. Conservation Assessment of Steelhead Populations in Oregon. Oregon Department of Fish and Wildlife. Portland, OR.

Chilcote, M. W. 2002. Spreadsheet with 2002 Oregon steelhead escapement updates.

Cichosz, T., D. Saul, A. Davidson, W. Warren, D. Rollins, J. Willey, T. Tate, T. Papanicolaou and S. Juul. 2001. Clearwater Subbasin Summary. Draft submitted to the Northwest Power Planning Council. Nov. 2001. 477 p.

Clanton, D. A. and J. F. Jarvis. 1946. Memorandum to Bureau of Fish Conservation re: field inspection trip to the Matilija-Ventura watershed in relation to the construction of the proposed Matilija Dam, dated 8 May 1946. Calif. Dep. Nat. Resources., Div. Fish Game, 3 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).

Comstock, R. 1992. Santa Clara River steelhead restoration assessment. US Fish and Wildlife Service, Western Washington Fishery Resource Office, Olympia, Washington, 10 pp. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).

Cooney, T. 2001. Upper Columbia River steelhead and spring chinook salmon quantitative analysis report. Part 1: run reconstructions and preliminary analysis of extinction risks. National Marine Fisheries Service. Hydro Program. Technical Review Draft

Cramer, D. 2002a. Portland General Electric - Clackamas winter steelhead adults. Portland General Electric. Data delivered via e-mail from Kathryn Kostow, Oregon Dept of Fish and Wildlife.

Cramer, D. 2002b. Portland General Electric - sandy winter steelhead adults. Portland General Electric. Data delivered via e-mail from Kathryn Kostow, Oregon Dept of Fish and Wildlife.

Cramer, S. P., and 12 co-authors. 1995. The status of steelhead populations in California in regards to the Endangered Species Act. Document prepared for Association of California Water Agencies, 167 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).

Cramer, S., R. Beamesderfer, P. Monk, K. Witty, A. Kalin, B. Lister & C. Akerman. 2002. Mid-Columbia steelhead trout population viability assessment. S.P. Cramer & Assoc. Progress Rept. Submitted to NMFS. April 2002.

CRFMP TAC (Columbia River Fisheries Management Plan Technical Advisory Committee). 1991. Summer steelhead. In Columbia River fish management plan: 1991 All species review. Technical Advisory Committee, U.S. v. Oregon. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Currens, K. P., S. L. Stone, and C. B. Schreck. 1987. A genetic comparison of rainbow trout (*Salmo gairdneri*) above and below Izee Falls in the John Day River, Oregon. Oregon Coop. Fish. Res. Unit Genet. Lab. Rep. 87(2), 34 p.

Currens, K. P., C. B. Schreck, and H. W. Li. 1990. Allozyme and morphological divergence of rainbow trout (*Oncorhynchus mykiss*) above and below waterfalls in the Deschutes River, Oregon. Copeia 1990:730-746.

Deinstadt, J. M., and Berry, M. A. 1999. California wild trout program, Hat Creek wild trout management plan, 1998 - 2003. California Department of Fish and Game, Sacramento, CA, 51 p.

Engblom, S. 1997. Compilation report for the 1996-97 Santa Ynez River Memorandum of understanding. SYRTAC.

Engblom, S. 1999. Compilation report for the 1998-99 Santa Ynez River Memorandum of understanding.

Engblom, S. 2001. 2001 Lower Santa Ynez River steelhead studies – annual report, Santa Barbara County, California.

Entrix. 1995. Historical steelhead run in the Santa Ynez River. Project No. 374100, prepared for Price Postel and Parma, 200 E. Carillo St., Santa Barbara, CA 93102.

Everest, F. H. 1973. Ecology and management of summer steelhead in the Rogue River. Oregon State Game Commission, Fishery Research Report 7, Corvallis, 48 p.

Foerster, R. E. 1947. Experiment to develop sea-run from land-locked sockeye salmon *(Oncorhynchus nerka kennerlyi*). J. Fish. Res. Board Can. 7(2):88-93.

Fulton, L. A., and R. E. Pearson. 1981. Transplantation and homing experiments on salmon, *Oncorhynchus* spp., and steelhead trout, *Salmo gairdneri*, in the Columbia River system: fish of the 1939-1944 broods. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC 12, 97 p.

Gephart, L. & D. Nordheim (eds) 2001. Tucannon Subbasin Summary. Prepared for the Northwest Power Planning Council. 222 pages.

Gorman, L. 2001. Hood steelhead at Powerdale dam. StreamNet Excel workbook provided to Paul McElhany from Leah Gorman 10/16/2001. This workbook is based on data provided by Rod French to ODFW/NMFS in the Microsoft Word file Data2000.doc on 7/31/2001.

Grass, A. 1995. Annual Report: Van Arsdale Fisheries Station, 1993-94. California Department of Fish and Game, Inland Fisheries. Administrative Report Number 95-5, 10p.

Griswold, K. E. 1996. Genetic and meristic relationships of coastal cutthroat trout (*Oncorhynchus clarki clarki*) residing above and below barriers in two coastal basins. M.S. Thesis, Oregon State Univ., Corvallis, OR, 83 p.

Hannon, J. and M. Healey. 2002. American River Steelhead Redd Surveys, 2001-2002. U. S. Bureau of Reclamation and California Department of Fish and Game. 19 p.

Hanson, C. H., J. Hagar, S. Englom, and B. Bemis. 1996. Synthesis and analysis of information collected on the fishery resources and habitat conditions of the lower Santa Ynez River: 1993 – 1996.

Harvey, B. C., J. L. White and R. J. Nakamoto. 2002. Habitat relationships and larval drift of native and nonindigenous fishes in neighboring tributaries of a coastal California river. Trans. Amer. Fish. Soc. 131: 159 – 170.

Henke, E. 1994. Letters to G. Bryant re: information on steelhead for the Administrative Record for west coast steelhead. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

Hulett et al. 1995. Studies of hatchery and wild steelhead in the lower Columbia basin. Washington Department of Fish and Wildlife. Report #RAD 95-3.

Hunt, W. 1999. Calapooia River St W Spawning Surveys, Winter Steelhead Counts Upper Willamette River, Late-Run Winter Steelhead Run Size Estimates and St W Returns to Minto Trap. ODFW.

Hunt, L. E., P. E. Lehman, and M. H. Capelli. 1992. Vertebrate resources at Emma Wood State Park and the Ventura River estuary, Ventura County, California: Inventory and management. Calif. Dep. Parks Rec., document dated 6 November 1992, 107 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

IEP (Interagency Ecological Program Steelhead Project Workteam). 1998. Monitoring, assessment, and research on Central Valley steelhead: status of knowledge, review of existing programs, and assessment of needs. Available online at: http://calfed.ca.gov/programs/cmarp/a7a11.html

IDFG (Idaho Department of Fish and Game). 1994. Documents submitted to the ESA Administrative Record for west coast steelhead by E. Leitzinger, 18 October 1994. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).

IDFG (Idaho Department of Fish and Game). 2002. Written comments submitted to National Marine Fisheries Service regarding status review.

James, G. and C. Scheeler. 2001. Walla Walla Subbasin Summary (Draft). Northwest Power Planning Council, Portland, OR.

Johnson, T. H. and R. Cooper. 1995. Anadromous game fish research and planning, July 1 1993-December 31, 1994. Washington Dept of Fish and Wildlife. Streamnet.org Reference.

Johnson, O. W., M. H. Ruckelshaus, W. S. Grant, F. W. Waknitz, A. M. Garrett, G. J. Bryant, K. Neely, and J. J. Hard. 1999. Status review of coastal cutthroat trout from Washington, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-37, 292 p.

Jonsson, B. 1985. Life history patterns of freshwater resident and sea-run migrant brown trout in Norway. Trans. Am. Fish. Soc. 114:182-194.

Kaeriyama, M., S. Urawa, and T. Suzuki. 1992. Anadromous sockeye salmon (*Oncorhynchus nerka*) derived from nonanadromous kokanees: Life history in Lake Toro. Sci. Rep. Hokkaido Salmon Hatchery 46:157-174.

Kennedy, T. 2002. Stanislaus River anadromous fish surveys 2000-2001. Report from Fisheries Foundation to A. Hamilton, USFWS, Sacramento, CA.

Kesner, W. D., and R. A. Barnhart. 1972. Characteristics of the fall-run steelhead trout *(Salmo gairdneri gairdneri*) of the Klamath River system with emphasis on the half-pounder. California Fish and Game 58(3):204-220.

Kier & Associates. 2001. Battle Creek salmon and steelhead restoration project. Draft Adaptive Management Plan. Sausalito, CA. 79 p.

Killam, D. 2002. Field notes for Thomes Creek 2002. California Department of Fish and Game, Red Bluff CA.

Kostow, K. 2002. Leaburg and McKenzie abundance. Data delivered via e-mail, September 2002.

Kostow, K. 2003. The biological implications of non-anadromous *Oncorhynchus mykiss* in Columbia basin steelhead ESUs. Report to NOAA Fisheries & ODFW. Draft report to NMFS. Jan. 13, 2003. 90 p.

Mallet, J. 1974. Inventory of salmon and steelhead resources, habitats, use and demands. Job Performance Report. Proj. F-58-R-1. Idaho Dept. of Fish and Game. Boise. Idaho.

Maslin, P. E., M. Lennox, and J. Kindopp. 1998. Intermittent streams as rearing habitat for Sacramento River chinook salmon (*Oncorhynchus tshawytscha*). CSU Chico unpublished report. 51 p.

McClure, M. M., E. E. Holmes, B. L. Sanderson & C. E. Jordan. In press. A large-scale multi-species assessment: Anadromous Salmonids in the Columbia River Basin. 45 p + figures and tables. Ecological Applications.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U. S. Dept. Commer. NMFS-NWFSC-42.

McElhany, P., T. Backman, C. Busack, S. Heppell, S. Kolmes, A. Maule, J. Myers, D. Rawding, D. Shively, and C. Steward. 2002. Willamette/Lower Columbia Pacific salmonid viability criteria. Draft report from the Willamette/Lower Columbia Technical Recovery Team. December 2002.

McEwan, D. R. 2001. Central Valley steelhead. In R. L. Brown, editor, *Fish Bulletin 179*, pages 1-43. California Department of Fish and Game, Sacramento, CA.

McEwan, D. R. 2001. Steelhead rainbow trout. Pages 418-425 *in* W. S. Leet, C. M. Dewees, C. M Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. University of California, Agriculture and Natural Resources, Publication SG01-11.

McEwan, D. R. 2001. Central Valley steelhead. In R. L. Brown, editor, *Fish Bulletin 179*, pages 1-43. California Department of Fish and Game, Sacramento, CA.

McEwan, D., and T. A. Jackson. 1996. Steelhead restoration and management plan for California. California Dep. Fish Game, 234 p. (Available from California Department of Fish and Game, Inland Fisheries Division, 1416 Ninth Street, Sacramento, CA 95814.)

Meyer Resources. 1988. Benefits from present and future salmon and steelhead production in California. Report to the California Advisory Committee on Salmon and Steelhead, 78 p. (Available from California Advisory Committee on Salmon and Steelhead Trout, 120 Schoonmaker Point, Foot of Spring Street, Sausalito, CA 94965.)

Monterey Peninsula Water Management District (MPWMD). 2001. Executive summary, 2000-20001, MPWMD Mitigation Program and Water Allocation Program Environmental Impact Report.

Moore, M. R. 1980. An assessment of the impacts of the proposed improvements to the Vern Freeman Diversion on anadromous fishes of the Santa Clara River System, Ventura County, California.

Moore, T. L. 2001. Steelhead Survey Report for Antelope, Deer, Beegum and Mill Creeks, 2001. CDFG Sacramento River Salmon and Steelhead Assessment Program. California Department of Fish and Game. 8 p.

Mullan, J. W., K. R. Williams, G. Rhodus, T. W. Hillman, and J. D. McIntyre. 1992. Production and habitat of salmonids in mid-Columbia River tributary streams. Monograph I, U.S. Fish and Wildlife Service, Box 549, Leavenworth, WA 98826, 489 p.

Myers, J. M., C. Busack, D. Rawding, and A. Marshall. 2002. Identifying historical populations of chinook and chum salmon and steelhead within the lower Columbia River and upper Willamette River evolutionary significant units. Draft report to the co-managers from the Willamette/Lower Columbia River Technical Recovery Team (10 May 2002).

Nehlsen, W., J.E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16: 4 – 21.

Nielsen, J. L., E. A. Heine, C. A. Gan and M. C. Fountain. 2000. Molecular analysis of population genetic structure and recolonization of rainbow trout following the Cantara spill. California Fish and Game 88:21-40.

NMFS (National Marine Fisheries Service). 1991. Notice of policy: Policy on applying the definition of species under the Endangered Species Act to Pacific salmon. Federal Register [Docket 910248-1255, 20 November 1991] 56(224):58612-58618.

NMFS (National Marine Fisheries Service). 1993. Endangered and threatened species; Illinois River winter steelhead in Oregon. Federal Register [Docket 930517-3117, 20 May 1993] 58(96): 29390-29392.

NMFS (National Marine Fisheries Service). 1997. Status Review Update for West Coast Steelhead from Washington, Idaho, Oregon, and California. Memorandum from the Biological Review Team to the NMFS Northwest Regional Office. July 7, 1997, 72 p.

NMFS (National Marine Fisheries Service). 1998*a*. Status review update for deferred and candidate ESUs of west coast steelhead (Lower Columbia River, Upper Willamette River, Oregon Coast, Klamath Mountains Province, Northern California, Central Valley, and Middle Columbia River ESUs). Pre-decisional ESA document, National Marine Fisheries Service.

NMFS (National Marine Fisheries Service). 1998*b*. Status review update for deferred ESUs of west coast steelhead: hatchery populations (Lower Columbia River, Klamath Mountains Province, Northern California, and Central Valley). Predecisional ESA document, National Marine Fisheries Service.

NMFS (National Marine Fisheries Service). 1999. Updated Review of the Status of the Upper Willamette River and Middle Columbia River ESUs of Steelhead. Memorandum for W. Stelle and W. Hogarth from M. Schiewe. January 12, 1999, 49 p.

NMFS (National Marine Fisheries Service). 2002. Memorandum for Frank L. Cassidy, Jr. (Northwest Power Planning Council) from Bob Lohn (NMFS), April 2002. (Available at http://www.nwr.noaa.gov/occd/InterimTargets.pdf)

Nobriga, M. 1995. Cosumnes River study. California Department of Fish and Game, Rancho Cordova, CA. 10 p.

Nobriga, M. and P. Cadrett. 2001. Differences among hatchery and wild steelhead: evidence from Delta fish monitoring programs. IEP Newsletter 14: 30-38.

Nordeng, H. 1983. Solution to the "char problem" based on Arctic char (*Salvelinus alpinus*) in Norway. Can. J. Fish. Aquat. Sci. 40:1372-1387.

Nowak, M.C. 2001. Draft Grande Ronde Subbasin Summary. Prepared for the Northwest Power Planning Council. 385 pages.

ODFW (Oregon Department of Fish and Wildlife). 1990. Santiam and Calapooia Rivers: Willamette River subbasin : salmon and steelhead production plan. Oregon Department of Fish and Wildlife. Northwest Power Planning Council.

ODFW (Oregon Department of Fish and Wildlife). 1991. Grand Ronde River subbasin salmon and steelhead plan. Prepared for Northwest Power Planning Council. 129 pp.

ODFW (Oregon Department of Fish and Wildlife). 1999. Personal communications for reconstructed run year estimates from punch cards for steelhead, 1956-1970. Unpublished.

ONRC (Oregon Natural Resources Council), Siskiyou Regional Education Project, Federation of Fly Fishers, Kalmiopsis Audubon Society, Siskiyou Audubon Society, Klamath/Siskiyou Coalition, Headwaters, The Wilderness Society, North Coast Environmental Center, Oregon Chapter of The Sierra Club, and The National Wildlife Federation. 1992. Petition for a rule to list the Illinois River winter steelhead as threatened or endangered under the Endangered Species Act and to designate critical habitat. Unpubl. manuscr., 16 p. (Document submitted to USDOC NOAA NMFS Northwest Region, Seattle, Washington, May 1992).

Puckett, L. K. 1969. Fisheries surveys on Thomes and Stony Creeks, Glenn and Tehama Counties, with special emphasis on their potentials for King Salmon spawning. California Department of Fish and Game, Water Projects Branch Administrative Report No. 69-3. 24 p.

Rawding, D. 2002a. Lower Columbia River summer-run steelhead. Excel Workbook sent from Dan Rawding (WDFW) to Paul McElhany via e-mail to Paul McElhany and Sarah Sydor, NWFSC.

Rawding, D. 2001b. Simsam (Steelhead). Unpublished data and documentation sent from Dan Rawding (WDFW) to Paul McElhany on 5/16/2001 as Excel file and Word document, via e-mail.

Reavis, B. 1991. Status of California steelhead stocks. In Pacific States Marine Fisheries Commission and Association of Northwest Steelheaders (organizers), International Symposium on Steelhead Trout Management, January 3-5, 1991, Portland, OR, p. 57 – 63.

Reese, C. D. and B. C. Harvey. 2002. Temperature-dependent interactions between juvenile steelhead and Sacramento pikeminnow in laboratory streams. Trans. Am. Fish. Soc. 131: 599 – 606.

Reynolds, F. L., T. J. Mills, R. Benthin and A. Low. 1993. Restoring Central Valley streams: a plan for action. California Department of Fish and Game, Sacramento, CA, 184 p.

Robertson, S. R. 1985. Clavey River wild trout habitat management plan. Stanislaus National Forest, Sonora, CA, 14 p. (from CV steelhead; not in master list)

Rode, M., and Weidlein, W. D. 1986. California wild trout management program, Fall River management plan. California Department of Fish and Game, Inland Fisheries Admin. Rpt. 86-2. 55 p. (from CV steelhead; not in master list)

Roelofs, T. D. 1983. Current status of California summer steelhead (*Salmo gairdneri*) stocks and habitat, and recommendations for their management. Submitted to USDA Forest Service, Region 5, 77 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).

Ruiz-Campos, G. and E. P. Pister. 1995. Distribution, habitat, and current status of the San Pedro Martir rainbow trout, *Oncorhynchus mykiss nelsoni* (Evermann). Bulletin of the Southern California Academy of Sciences, 94(2): 131 – 148.

Schill, D. J. and R. L. Scarpella. 1997. Barbed hook restrictions in catch-and-release trout fisheries: a social issue. N. Am. J. Fish. Man. 17: 873 – 881.

Servheen, G. Draft Salmon Subbasin Summary. Prepared for the Northwest Power Planning Council. 481 p. + app.

Shapovalov, L. 1944. Preliminary report on the fisheries of the Santa Ynez River System, Santa Barbara County, California. CDFG Report, 22 pp.

Shapovalov, L. and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. Calif. Dep. Fish Game Fish Bull. 98, 375 pp.

Sharp, B. 2001. Klickitat Subbasin Summary. Northwest Power Planning Council, Portland, OR.

Shea, K., and M. Mangel. 2001. Detection of population trends in threatened coho salmon (*Oncorhynchus kisutch*). Can. J. Fish. Aquat. Sci. 58: 375-385.

Smith, J. J. 1994. Abundance of coho and steelhead in Redwood Creek in 1994. Department of Biological Sciences, San Jose State University. San Jose, CA.

Smith, J. J. 1992. Distribution and abundance of juvenile coho and steelhead in Waddell, Scott and Gazos Creeks in 1992. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 1994. Distribution and abundance of juvenile coho and steelhead in Scott and Gazos Creeks in 1993. Department of Biological Sciences, San Jose State University. San Jose, CA.

Smith, J. J. 1994. Distribution and abundance of juvenile coho and steelhead in Scott and Waddell Creeks in 1988 and 1994: Implications for status of southern coho. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 1995. Distribution and abundance of juvenile coho and steelhead in Waddell, Scott and Gazos Creeks in 1995. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 1996. Distribution and abundance of coho and steelhead in Redwood Creek in November 1996. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 1996. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 1995. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 1996. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 1996. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 1997. Distribution and abundance of coho and steelhead in Redwood Creek in fall 1997. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 1998. Distribution and abundance of coho and steelhead in Redwood Creek in fall 1998. San Jose, California.

Smith, J. J. 1998. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 1997 and the implications for status of southern coho. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 1998. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 1998. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 1999. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 1999. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 2000. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 2000. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 2000. Distribution and abundance of juvenile coho and steelhead in Redwood Creek in fall 2000. San Jose, California.

Smith, J. J. 2001. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 2001. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 2001. Distribution and abundance of juvenile coho and steelhead in Redwood Creek in fall 2001. Department of Biological Sciences, San Jose State University. San Jose, California.

Smith, J. J. 2002. Distribution and abundance of juvenile coho and steelhead in Redwood Creek in fall 2002. Department of Biological Sciences, San Jose State University. San Jose, California.

Snider, B., and R. G. Titus. 1998. Evaluation of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing; November 1995 - July 1996. California Department of Fish and Game, Stream Evaluation Program Technical report 98-5.

Snider, B., and R. G. Titus. 2000a. Timing, composition and abundance of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing; October 1996 - September 1997. California Department of Fish and Game, Native Anadromous Fish and Watershed Branch, Stream Evaluation Program Technical report 00-4.

Snider, B., and R. G. Titus. 2000b. Timing, composition and abundance of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing October 1997-September 1998. California Department of Fish and Game, Habitat Conservation Division, Native Anadromous Fish and Watershed Branch, Stream Evaluation Program Technical Report 00-5.

Snider, B., and R. G. Titus. 2000c. Timing, composition and abundance of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing; October 1998 - September 1999. California Department of Fish and Game, Native Anadromous Fish and Watershed Branch, Stream Evaluation Program Technical report 00-6.

Snider, W. M. 1983. Reconnaissance of the steelhead resource of the Carmel River drainage, Monterey County. Calif. Dep. Fish Game, Environmental Services Branch Admin. Rep. 83-3., 41 p. (Available from California Department of Fish and Game, Inland Fisheries Division, 1416 Ninth Street, Sacramento, CA 95814.)

Snyder, J. O. 1925. The half-pounder of Eel River, a steelhead trout. Calif. Fish Game 11(2): 49-55.

Stephens, S. J., Christenson, D. P., Lechner, M., and Werner, H. 1995. Upper Kern Basin fishery management plan. California Department of Fish and Game, Sacramento, CA, 86 p.

Stoecker, M.W. and CCP (Conception Coast Project). 2002. Steelhead assessment and recovery opportunities in Southern Santa Barbara County, California. Conception Coast Project, Santa Barbara.

Titus, R. G., D. C. Erman, and W. M. Snider. MS. History and status of steelhead in California coastal drainages south of San Francisco Bay.

Titus, R. G. and C. D. Vanicek. 1988. Comparative hooking mortality of lure-caught Lahontan cutthroat trout at Heenan Lake, California. Calif. Fish Game 74: 218 – 225.

USFWS (U.S. Fish and Wildlife Service). 2000. Anadromous fish restoration actions in the Butte Creek Watershed. Programmatic Environmental Assessment. Sacramento, CA.

Waples, R. S. 1998. Willamette Steelhead. Memorandum to Mike Delarm and Garth Griffin, NMFS Regional Office, Portland, 2 July 1998. 2 p.

WDF (Washington Department of Fisheries), Washington Department of Wildlife (WDW), and Western Washington Treaty Indian Tribes (WWTIT). 1992. 1992 Washington State salmon and steelhead stock inventory (SASSI). Wash. Dep. Fish Wildl., Olympia, 212 p. + 5 regional volumes. (Available from Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, WA 98501-1091.)

WDFW ((Washington Department of Fisheries and Wildlife). 1997. "Preliminary stock status update for steelhead in the Lower Columbia River, Washington (WDFW Kalama Research)." Data via Michelle McClure; references from Eli Holmes.

Withler, R. E. 1988. Genetic consequences of fertilizing chinook salmon (*Oncorhynchus tshawytscha*) eggs with pooled milt. Aquaculture 68: 15-25.

Workman, M. L. 2001. Lower Mokelumne River upstream fish migration monitoring conducted at Woodbridge Irrigation District Dam, August 2000 through April 2001. East Bay Municipal Utility District, Lodi, CA. 21 p.

Yoshiyama, R. M., F. W. Fisher, and P. B. Moyle. 1998. Historical abundance and decline of chinook salmon in the Central Valley region of California. N. Am. J. Fish. Man. 18:487-521.

Zimmerman, C. E. and G. H. Reeves. 2000. Population structure of sympatric anadromous and nonanadromous *Oncorhynchus mykiss*: evidence from spawning surveys and otolith microchemistry. Can. J. Fish. Aquat. Sci. 57:2152-2162.